Specifications for Commercial Refrigeration

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ARB Workshop on Stationary Source High-GWP Early Action Items

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Outline

- Background
- Data Sources, Emissions and Trends
- Existing Regulations & International Experience
- Potential Control Strategies
- Emission Reduction Projections
- Regulatory Concepts & Costs
- Data Gaps, Ongoing Research, Questions
- Working Group Formation
- Timeline & Contact Information

Background

- **Types of Commercial Refrigeration Systems**
  - Direct expansion (DX) systems used in supermarkets, cold storage warehouses, industrial food processing
  - Standalone equipment (open and closed display cases) and refrigerated vending machines

Background (continued)

- **Commercial Refrigeration Systems Emissions Sources**
  - Direct refrigerant emissions occur during equipment manufacturing/charging, lifetime (from leaks, ruptures, maintenance), and end-of life (EOL)
  - Indirect emissions (CO_2E emissions resulting from energy use) occur during equipment manufacture, lifetime operation, and EOL

Existing Systems

- **Direct Expansion (DX) Systems**
  - Also called centralized or multiplex systems
    - Supermarkets, cold storage warehouses, built-up refrigeration/freezing systems for food processing, etc.
  - High direct emissions
    - Leaks result from vibration and thermal expansion of numerous pipes, threaded joints, fittings, and valves
    - Ruptures can result in huge refrigerant losses
  - High indirect emissions due to energy inefficient system components, designs
    - Lack of heat recovery in some systems, open cases, poor air curtains, inefficient lighting, use of anti-sweat heaters, etc.

Existing Systems (continued)

- **Standalone Equipment and Vending Machines**
  - Low direct emissions (EOL), high indirect emissions
  - Large numbers of standalone cases and vending machines in CA
    - ~500,000 refrigerated vending machines in CA
    - Open and closed standalone cases yet to be enumerated

Data Sources, Emissions, and Trends: Rule 1415

- **Rule 1415 Data**
  - **Reporting of annual ODS usage for RAC systems > 50 lbs in SCAQMD only**
    - **Leak rates exceed 35% for 11% of systems, 100% for 2.7% of systems**
    - **The top 15 SIC codes emit 80% of total**

SIC Code	Description	Emissions MTCO2E/year	Facilities
5400	FOOD STORE	94820	255
5490	GROCERY-RETAIL	54116	207
2013	FOOD PROCESSOR	11001	5
4960	DISTRICT HEATING AND COOLING	6188	10
8700	OFFICE BUILDING	5137	141
4810	TELEPHONE COMMUNICATION	5071	137
5142	WHOLESALE TRADE NON-DURABLE GOODS/PACKAGED FROZEN FOODS	4643	1

Data Sources, Emissions, and Trends: ARMINES

- **Commercial RAC Inventory Development for California**
  - Contractor Denis Clodic/ARMINES
  - Preliminary estimates, DX systems

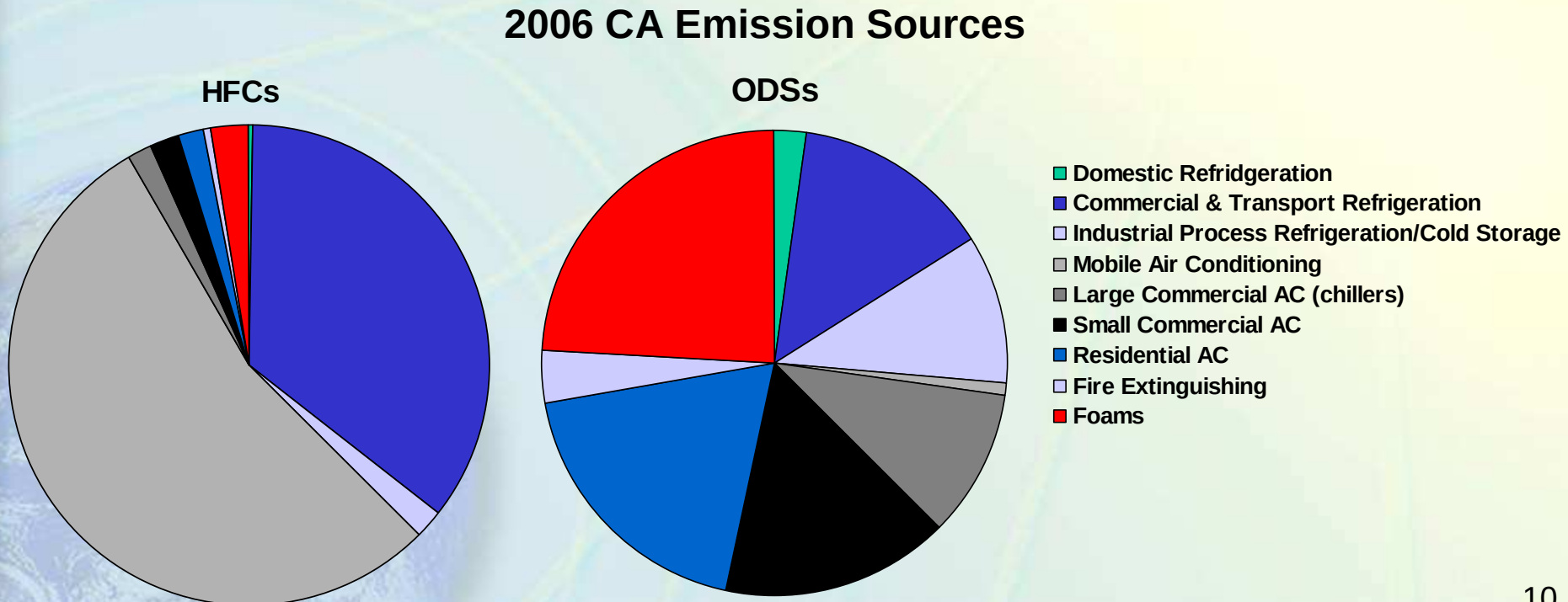
Direct emissions or leaks	**Indirect emissions or energy use**
Leak rates ~30% per year or ~2.7 $MMTCO_2E$	Indirect CO_2 emissions ~2.3 $MMTCO_2E$
Typical CA DX system charge ~2800 lbs (large release potential)	
Banked refrigerant in CA DX systems is ~7.5 $MMTCO_2E$	

Data Sources, Emissions, and Trends: ARMINES (continued)

- **CA RAC Inventory: Preliminary Estimates, Continued**
  - Standalone systems, direct emissions
    - Emission rates estimated at 1% of the charge per year for stand-alone equipment, most of which are EOL emissions
  - Standalone systems, indirect emissions
    - More standalone systems in CA than anticipated; energy use ~50% of the commercial refrigeration total

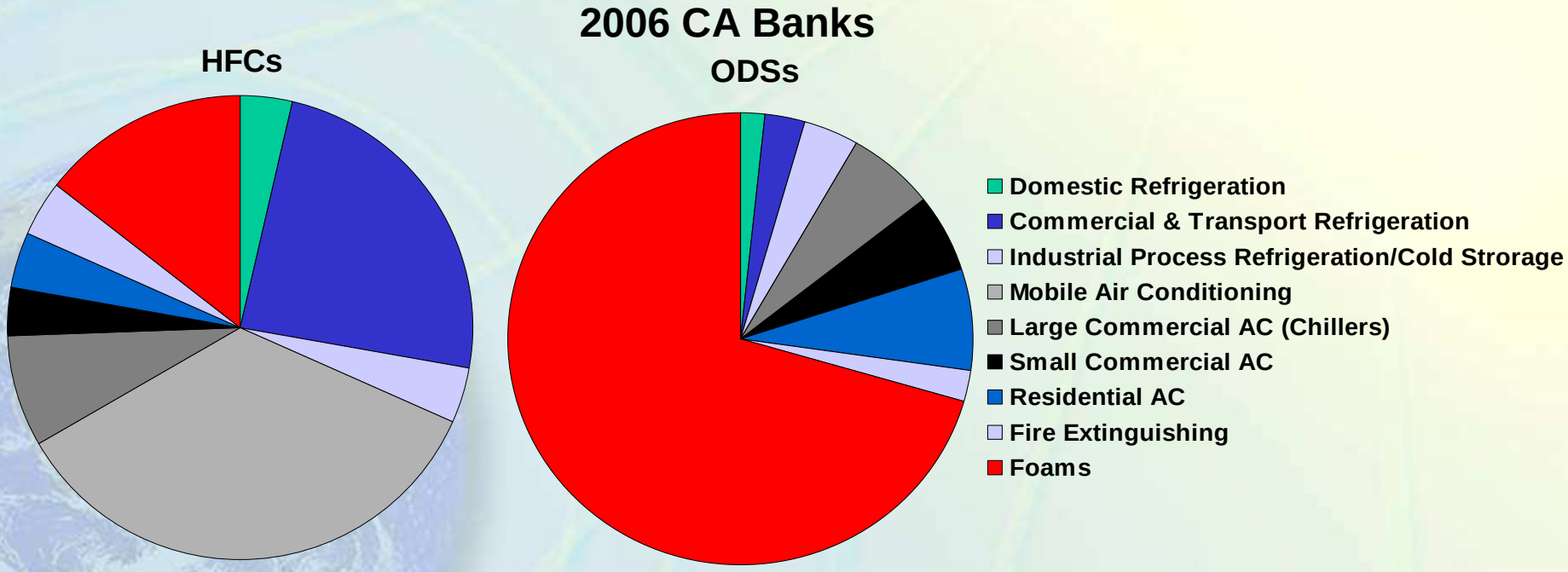
Data Sources, Emissions, and Trends: USEPA Vintaging Model

- **Estimated CA Commercial/Industrial/Cold Storage Refrigeration Emissions**
  - HFC emissions ~2.5 $MMTCO_2E$
  - ODS emissions ~6 $MMTCO_2E$



Data Sources, Emissions, and Trends: USEPA Vintaging Model

- **Estimated CA Commercial/Industrial/Cold Storage Refrigeration Banks**
  - HFC Banks ~12.5 $MMTCO_2E$
  - ODS Banks ~35 $MMTCO_2E$



Existing Regulations

- **ODSs Have Some Sales, Record-Keeping/Reporting, Technician Certification, and Emissions Restrictions**
  - Section 608 of CAAAs and SCAQMD Rule 1415
- **HFCs Subject to "No Venting" Provision of CAAAs, Section 608**

International Experience

- **STEK Regulation**
  - The Dutch regulation on leak-free refrigeration equipment, which includes the following:
    - Flared joints shall not be used
    - Pipes shall be joined by welded or brazed joints
    - Systems with a charge >3 kg shall be inspected annually
    - Systems with a charge of >1000 kg shall be under constant supervision
    - Logbooks must be kept for all systems with a charge >3 kg
    - Refill or top-off is only permitted if leaks are identified and repaired

International Experience (continued)

- **EU F-Gas Regulation**
  - Similar to, but more restrictive than, Section 608 of the CAAAs
    - Covers only Kyoto gases
    - Requires containment, record-keeping, recovery, training/certification, reporting, labeling, use control
    - Also specifies certain market prohibitions (shoes and tires containing SF_6, one-component foams, one-way cylinders, aerosols, etc.)

Potential Control Strategies

- **DX Systems**
  - Direct Emissions Reduction
    - Indirect or Secondary Loop (SL) Systems
      - Can utilize low-GWP refrigerants, or significantly reduced quantities of high-GWP refrigerants
        - Charge reduction important to reduce emissions from ruptures
      - Automatic leak detection in machine rooms possible
        - Benefits include easier leak detection/repair, fewer refrigerant purchases

Potential Control Strategies (continued)

- **DX Systems, Continued**
  - Indirect Emissions Reduction
    - Machine Room Technologies
      - Evaporative condensers
      - Floating head pressure controls
      - Heat recovery
    - Display Case Technologies
      - Add doors to display cases
      - Improved air curtains
      - Energy-efficient reach-ins, evaporator and condenser fan motors, compressor systems, lighting
      - Anti-sweat heater controls
      - Hot gas defrost

Potential Control Strategies (continued)

- **Standalone Systems and Vending Machines**
  - Direct Emissions Reduction
    - Alternative refrigerants currently possible (i.e. CO_2)
    - Future innovations may include thermoacoustic or magnetic refrigeration

Potential Control Strategies (continued)

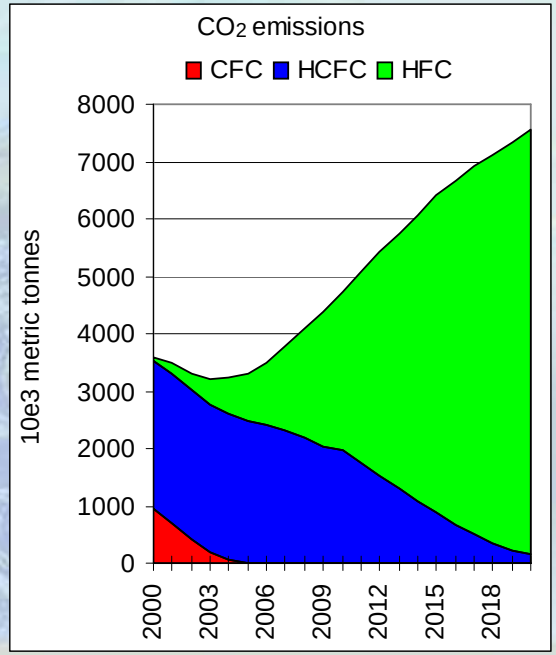
- **Standalone Systems and Vending Machines**
  - Indirect Emissions Reduction
    - Compressor and component improvements (i.e. efficient lighting, fans, anti-sweat heaters, addition of doors)
    - USDOE is developing energy conservation standards for:
      - Self-contained and remote display cases (ASHRAE 72, 2005, for open and closed display cases)
      - Vending machines (ASHRAE 32.1, 2004)
      - Walk-in coolers and freezers (no test methods yet)

Emission Reduction Projections

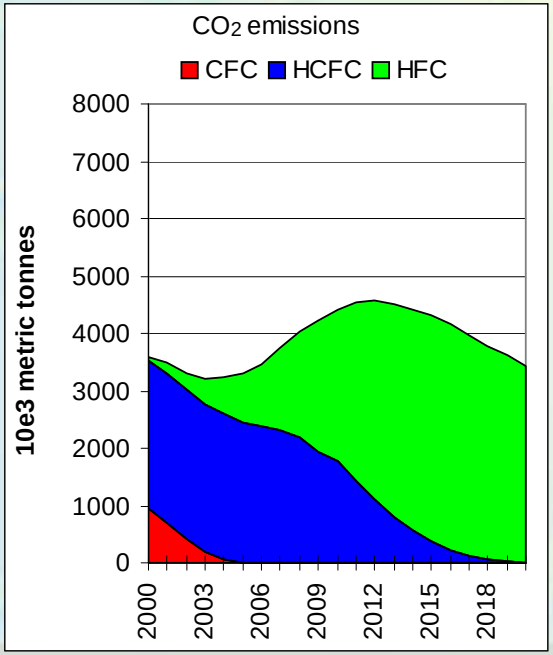
- **DX System Direct Emissions 2020 Forecast: BAU, SL, and SL With Low-GWP Refrigerants**

  Source: Interim Draft Report, ARMINES, Centre énergétique et procédés - CEP
  http://www-cep.ensmp.fr/english/

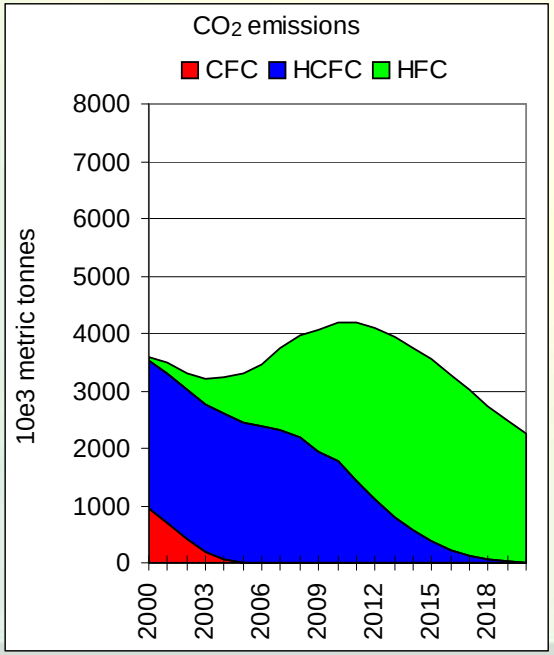
Business As Usual



Secondary Loop (SL)

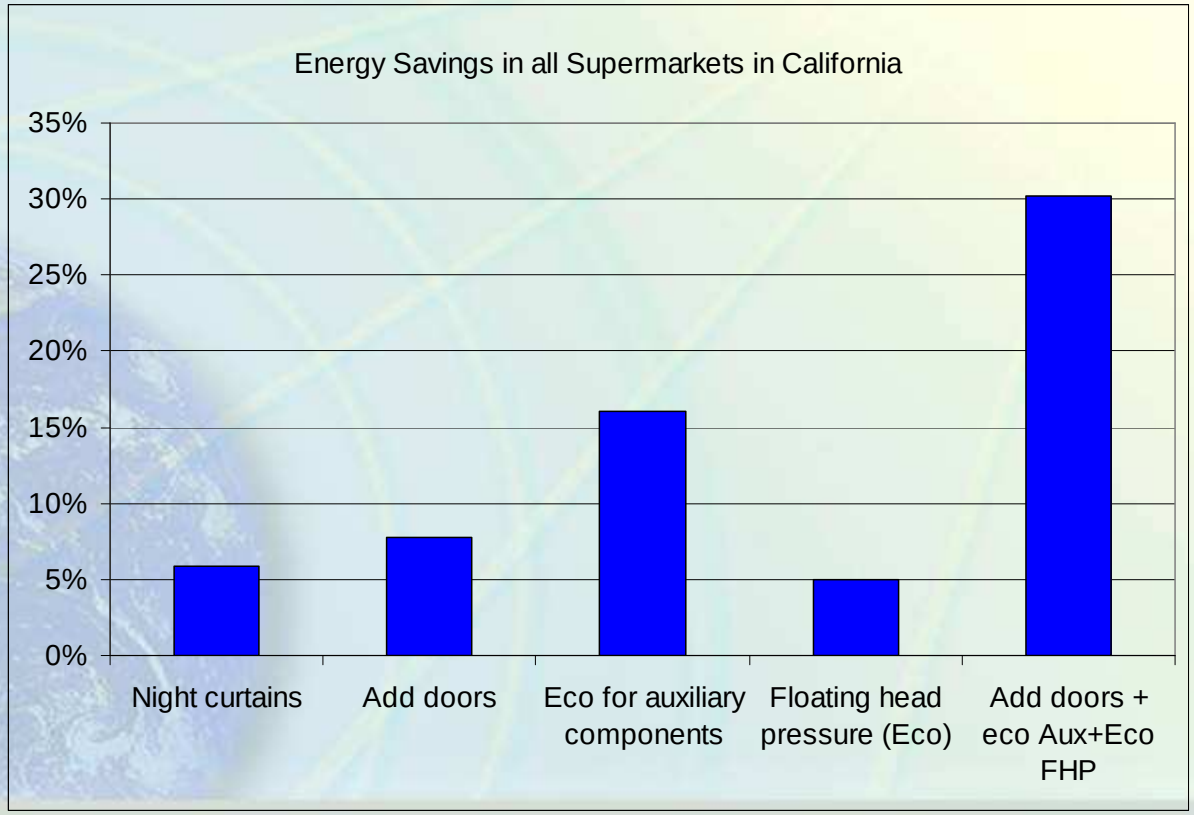


SL + Low-GWP



Emission Reduction Projections (continued)

- **Energy Savings For CA Supermarkets**
  - 30% savings relative to BAU
  - 0.7 TWh/year or 0.3 $MMTCO_2E$/year, in 2007; 3 $MMTCO_2E$ by 2020



Regulatory Concepts

- **New Refrigeration Systems**
  - Limit direct emissions to X% for all new systems
    - Will likely require installation of indirect systems
  - Full accessibility to all piping
  - Automatic leak detection
- **Existing and New Retail Food Systems**
  - Increase energy efficiency by 30%

Costs

- **First Approximation of Costs**
  - Installation costs expected to dominate over energy saving device costs for new systems
    - USEPA and Oak Ridge National Lab estimate that for a SL system with HFC refrigerant, installation costs will be 20% higher than baseline DX system
      - Using ammonia refrigerant results in installation costs 75% higher than the baseline case
      - Maintenance costs are expected to be lower than for the baseline case

Costs (continued)

- **First Approximation of Costs, Continued**
  - Costs could largely be offset by maintenance, refrigerant, and energy savings benefits
    - Benefits depend largely on future refrigerant and energy costs

Data Gaps, Ongoing Research

- **Data Gaps**
  - Costs, benefits, and payback periods associated with installing new systems and upgrading existing systems
- **Ongoing Research**
  - RAC inventory and energy efficiency contract with Denis Clodic/ARMINES

Questions

- Questions
  - What should trigger the upgrading of existing systems (i.e. repair or future compliance date)?
  - Should DOE test methods be adopted earlier for standalone equipment and vending machines?

Working Group Formation

- **Focused Technical Group Formation**
- **Identify Key Stakeholders and Agency Partners**
- **Meet at Least Twice, Over Several Months**
- **First Meeting in March 2008**
- **If Interested, Please Provide Your Information**

Timeline (Estimated)

March 2008	Working Group/Stakeholder Formation
Summer 2008	Working Group/Stakeholder Consultation Meeting
Winter 2008	1st Public Workshop to Discuss Proposed Control Strategies and Options
Spring 2009	2nd Working Group/Stakeholder Consultation Meeting
Winter 2009	2nd Public Workshop on Proposed Strategies
Summer 2010	Regulatory Language and ISOR Finalized
Winter 2010	Board Meeting on Action

Contact Information

- **Whitney Leeman, Ph.D.**

  Greenhouse Gas Reduction Strategies Section

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- **More Information**
  - Visit: http://www.arb.ca.gov/cc/commref/commref.htm
  - Join list serve at: http://www.arb.ca.gov/listserv/listserv.php

Questions?